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"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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LOOMIS'S CONTRIBUTIONS TO METEOROLOGY.

Contributions to Meteorology. By Elias Loomis, LL.D., Professor of Natural Philosophy and Astronomy in Yale College, &c. Revised Edition. Chapter II. (New Haven, Conn., 1887.)

IN Chapter I. of the revised issue of these valuable contributions to meteorology, Prof. Loomis summarised, and in some directions materially extended, the laborious investigations on which he had been engaged for the previous ten years, with reference to areas of low atmospheric pressure—their form, magnitude, direction, and velocity of movement (NATURE, vol. xxxiii. p. 49). In Chapter II. he similarly deals with the allied problems of meteorology which group themselves round areas of high atmospheric pressure, investigates their form, magnitude, direction, and velocity of movement, and concludes by tracing some of the more important relations of areas of high to areas of low atmospheric pressure.

It is premised that areas of high pressure exhibit characteristics quite unlike those which attend areas of low pressure. A typical example, contrasting the two sets of phenomena, is given in the great storm of February 5, 1870, where, in the centre of the Atlantic, pressure fell to 27·33 inches, whilst at the same time, and contiguous to this great cyclone, there occurred a strongly-marked anticyclone in Europe, where, over an extensive region, pressure rose to upwards of 31·00 inches. Near the centre of the cyclone the winds blew with hurricane force, but near the centre of the anticyclone the atmosphere was well-nigh calm. In the cyclone the winds circulated about the low centre in a direction contrary to the hands of a watch, with, at the same time, a decided tendency inwards upon the centre of low pressure; whereas in the anticyclone the winds circulated about the high centre in the same direction as that of the hands of a watch, with a decided tendency [illegible]ards from the centre of high pressure.

[illegible] egards their form, cyclones nearly always approximate closely to the circular, elliptical, or oval forms; but on the other hand, the departures of anticyclones from the circular form are nearly always quite palpable; indeed, we rarely find an isobar about a centre of high pressure which does not clearly deviate from the figure of an exact circle. The isobars are generally elongated, and are thus elliptical rather than circular, and the elongation is sometimes very great.

In order to ascertain the general form of the isobars of anticyclones, Prof. Loomis has examined and measured with care 238 well-defined cases, shown on the United States weather-maps. The result indicates that the average ratio of the longest to the shortest diameter was 1·91. Whilst the longest diameter may be turned in any direction, 72 per cent. of the cases occurred in the azimuth from 0° to 90°, the direction of maximum frequency being N. 44° E. It is noteworthy that these results intimately agree with those found for low-pressure areas, showing, together with other results, how intimately cyclones and anticyclones are connected.

A similar investigation has been carried through as regards these two great systems of pressure for the Atlantic and Europe. In this part of the inquiry the number of cases examined was 252, which showed that the average ratio of the longest to the shortest diameter was 1·84; and as respects the direction of the longest diameter, 69 per cent. of the cases occurred in azimuth from 40° to 130°, the direction of maximum frequency being N. 75° E. Thus, while there is a remarkable correspondence between the results for these two great regions of the globe as respects the form of anticyclonic isobars, there is not the same accord as to the prevalent direction of the longest diameter. It may be well to emphasise here this vital difference between the anticyclones of North America, and those of the much larger Europasian continent. About three-fourths of these anticyclones occurred during the six colder months of the year.

When an area of high pressure is situated between two areas of low pressure not far apart from each other, the anticyclone generally takes a very elongated form, and sometimes the isobars surrounding this high area extend a distance of several thousand miles, with but little

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curvature. The isobars for January 14, 1876, show between one widespread low-pressure area over the North Atlantic and Arctic Oceans, and another over the Mediterranean, a belt of high pressure, with nearly straight and parallel isobars of 30·3 and 30·5 inches, extending from south-west to north-east for about 3000 miles.

With the view of throwing some light on the origin of anticyclones, all those cases in the States in which the barometer rose to 30·85 inches or upwards during the twelve years ending with 1884 were examined. Of such anticyclones there were fifty-two cases, distributed as follows: in October one, November ten, December eight, January fourteen, February sixteen, and March three; the earliest having occurred on October 26, and the latest on March 12. The majority of the whole number of cases occurred north of lat. 46°, only two being south of lat. 40°; and the influence of longitude was equally strongly marked: 82 per cent. of the cases occurred west of long. 90° W., and nearly half of the number west of long. 100° W. These areas of high pressure indicate a general movement towards the south-east, the prevalent direction being S. 40° E. at a mean velocity of twenty-one miles an hour.

An instructive point in the history of anticyclones is the low temperature which accompanies them. It is shown from a somewhat exhaustive examination that, when pressure is unusually high, temperature is generally very much below the mean, and that the amount of the depression increases with the height of the barometer; and it is further shown that with a given barometric pressure the temperature depression is greatest in the neighbourhood of Manitoba, or approximately in the centre of the continent. These relations are sometimes shown on the weather-maps with a surprising closeness, of which an instructive instance is figured on Plate XXV., which gives the isobars and thermic isabnormals for December 24, 1872. In the case of the more strongly pronounced anticyclones, the depression of the temperature below the mean for the season is on the average 38°·7. The maximum temperature depression may occur in any direction from the place of highest pressure, but it is generally about 400 miles distant from it, and most frequently on its northern side. Indeed, in only 12 per cent. of the cases examined did the place of greatest temperature depression correspond exactly with the place of highest pressure. Similar relations exist as regards the summer anticyclones, with the important differences that their maximum pressure is generally about half an inch less than that of winter cyclones, and their temperature depression below the mean of the season only about 8°·0.

The average breadth of the American anticyclones is 2587 miles, which is nearly equal to the breadth of the continent in lat. 40°, and an examination of the maps of the *International Bulletin* show that a large number of high-pressure areas are 4000 miles in length. The average distance from the centre of an anticyclone to the centre of the cyclone on its east side is 2371 miles, and to the centre of the cyclone on its west is 2381 miles, being thus nearly equal. Since, however, the average value of the lowest isobars of the cyclones on the east side is 29·190 inches, and on the west 29·570 inches, it follows that the gradients on the east side of the United States anticyclones are about twice as great as those on the west side. This is an extremely valuable result, as showing the powerful influence of the Atlantic in lowering atmospheric pressure, and thus intensifying storms as they near its seaboard in their course eastwards. Indeed, as regards those cyclones which show a pressure not exceeding 29·00 inches at their centre—in other words, the more important storms—five-sixths of the number occurred near the Atlantic. The cases examined numbered 131, and were distributed through the months as follows, beginning with January: 14, 16, 25; 10, 4, 1; 0, 2, 2; 7, 26, and 24; there having thus occurred 105 during the five months from November to March, and only 5 during the four months from June to September.

It is shown that, while an area of extraordinarily high pressure uniformly has an area of low pressure both on its east and west sides, the barometer in these areas seldom sinks very low, and when it does sink very low the centre of the low pressure is very remote; and on the other hand that an area of very low pressure has an area of high pressure both on its east and west sides, but in these areas of high pressure the barometer seldom rises very high.

As regards anticyclones, Prof. Loomis makes it abundantly clear that the height to which pressure rises in their centres is approximately proportioned to the depression of temperature over the region at the time. In these circumstances, the air, being condensed by the cold, sinks more and more into the lower regions of the atmosphere, thus leaving a less pressure in the upper regions than prevails all round at these heights, and consequently upper currents set in all round towards and upon the anticyclonic region, by which its high pressure is further increased. Hence it follows that it is over one and the same region, viz. the more inland portions of the Europasian continent, where depressions of temperature are greatest, most widespread, and most persistent, and where the best-pronounced anticyclones occur in the colder months of the year. This state of things is entirely due to the great extent of the Old continent, by which a very large portion of it is remote from the disturbing influence of the ocean. The same cause explains a singular feature of the anticyclones of this part of the globe, viz. the absence they frequently show, sometimes for weeks together, of any movement of translation over the earth's surface, being so different in this respect from the anticyclones of the comparatively narrow continent of America, which have a distinctly progressive movement towards the south-east, already referred to.

On the other hand, low pressures are distinguished by the relatively high temperature which accompanies them. The highest temperature occurs about 300 miles on the south or east side of the low centre of the cyclone, the average excess above the mean temperature being 22°·3. No inconsiderable part of the low pressure of cyclones is occasioned by the high temperature and excessive moisture which accompanies them. But, while all, or nearly all, of the high pressure of anticyclones may be accounted for by the very low temperatures which overspread the same region at the same time along with the resulting upper currents concentrating upon them from adjoining cyclonic regions, it is quite different with the low pressures of cyclones. In the case of cyclones the problem is complicated by the strong winds, the copious precipitation, and the ascending currents, which affect the results in ways which no physicist has yet been able to explain.

The problem of the weather would be immensely simplified if it could be explained, first, how it is that air highly heated and approximately saturated with aqueous vapour comes to overspread a definite well-marked region, usually a very extensive one, while the atmosphere over contiguous regions remains relatively cold and dry; and, secondly, how the low temperature which is so characteristic a feature of anticyclones and of the rear of cyclones has its origin. The complete changes which weather-maps show us to take place in these respects over enormous tracts of the earth's surface within even such brief spaces of time as twenty-four hours, point to volumes and velocities of translation of masses of air through the upper currents which meteorologists have yet scarcely taken cognisance of. Prof. Loomis's paper is a well-worked-out and valuable contribution towards the solution of this all-important practical problem.

THE GAME OF LOGIC.

The Game of Logic. By Lewis Carroll. (London: Macmillan and Co., 1887.)

MR. "LEWIS CARROLL'S" new book has both the merit and the sterility which might be expected from a fresh and rather independent system of diagrammatic or visual logic. That is to say, it is ingenious and closely worked out, but cannot be said to advance either our theoretic knowledge of reasoning processes or the more practical craft of dealing with assertions and arguments as found in ordinary life. Perhaps so trying a standard ought not in fairness to be applied to the work before us, which is intended—so the preface and the title hint—to amuse those who would otherwise play with some less instructive puzzle. But it is because it seems unlikely that "The Game of Logic" will be patiently studied as a game, or would reward such patience by providing "an endless source of amusement," that one is inclined to consider it rather as a contribution to visual logic than to any other form of literature.

Technically speaking, the propositions contemplated are "extensive" and "existential." That is to say, all assertions are supposed to be concerned with things as members of classes, and to be translatable into the form "Of the class ux there are none (or 'some') which are uy"; so that, for example, "I feel much better" becomes (pp. 50, 70, and 9) "Of the class of persons who are I, there are none who do not feel much better, and there are some who do"; and "There is no one in the house but John" becomes "Of the class of persons who are not John, none are in the house." Of course these are here chosen as examples of difficulty in translation: a great many propositions can be much more naturally treated as expressing class-relations.

Every assertion is thus supposed to perform two functions: it provides a certain number of labelled compartments, and it tells us that one or more of these is either empty or "occupied." If, for example, we regard a given proposition as containing only two terms, x and y, the compartments provided are four in number: $x\,y$, x *non-y*, *non-x* y, and *non-x non-y*. (Mr. Lewis Carroll however adopts Mr. Maccoll's neater notation for the negative terms.) And if two such propositions have one term in common—say, if the first speaks of x and m, and the second of y and m—the two can be taken together as one complex assertion providing eight compartments, and giving, under certain conditions, more information about x and y than is to be found in either proposition when taken singly.

As regards the division of the universe into compartments, there is little to distinguish Mr. Lewis Carroll's system from others which, like Boole's or Jevons', make use of a similar framework; and nothing to distinguish it from Mr. Venn's, except the form of picture employed. But the special features consist in (1) making all affirmative propositions assume the real existence of the subject, and (2) providing for the expression of certain forms of proposition which are usually found difficult to put into diagrams. For example, by means of the restricted sense given to the assertion that a compartment is *occupied*, the "particular" proposition, which often causes trouble, becomes easily expressed. In Mr. Venn's scheme, propositions either tell us that a compartment is empty or else tell us nothing about it, whereas here the information that a compartment is *occupied* (meaning merely "not empty") can also be distinctly given; so that to mark the compartment xy as "occupied" expresses "some x are y" and "some y are x" together. Again, "some x exist," "no x exist," and "*only* some x are y" are readily and neatly represented; and a distinction, due to the assumption of real existence, is drawn between "all x are y" and "no x are *non-y*," and similarly between "no x are y" and "all x are *non-y*."

The author is in one or two instances not quite fair to the more old-fashioned logicians. It is not the case, as stated on p. 30, that those who regard the universal negative as asserting incompatibility of attributes would therefore regard the assertion "No policemen are eight feet high" as *false*. They might rather be inclined to consider any such *a priori* treatment of it as a case of *petitio principii*, since, if the assertion be supposed to intend giving information at all, the question whether or no the attributes *are* compatible is supposed to be at issue. Again, there are probably few logicians in existence who would simply turn away with scorn from the premises given on p. 35. Even the more pedantic would rather suggest that a very slight verbal alteration performed on the minor premise by recognised processes (conversion and obversion) would give a legitimate syllogism in *celarent*. But no doubt Mr. Lewis Carroll's method deals with such premises more directly.

It is held by some who ought to know, that logic might be taught at a much earlier age than is now the fashion; and possibly the book should be regarded as an attempt to make a beginning in this direction. If so, the advantages and disadvantages of the scheme seem about evenly balanced. Certainly the diagram is simple to draw, full in its information, and easily read; but these good qualities are gained at some expense. The difficulty of forcing all assertions into the forms of class-inclusion is not indeed peculiar to Mr. Lewis Carroll's system; but the assumption of the real existence of the subject leads, in certain cases, to additional troubles of interpretation.